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The Use of Intraosseous Access in Adult Resuscitation Among Healthcare Providers in Saudi Arabia

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Abstract **Objectives:** Establishing vascular access is essential in the management of critically ill patients. Intraosseous (IO) access involves inserting a specialized needle into the bone to deliver medications and fluids or collect lab samples and is particularly valuable when intravenous access is challenging or time sensitive. **Objective:** This study aimed to assess the frequency of IO access use during adult resuscitation and to identify barriers encountered by physicians across different specialties and training levels in Saudi Arabia. **Method:** A cross-sectional study was conducted using an online survey distributed via email to eligible physicians between March 2023 and March 2024. The survey targeted physicians from both public and private hospitals, including those in Emergency Medicine, Intensive Care, General Surgery, Internal Medicine, Anesthesiology, and Family Medicine, across all training levels. **Results:** A total of 231 healthcare providers participated, with a mean age of 26.1±12.8 years. There were 123 (53.2%) males and 108 (46.8%) females. Interns comprised the largest group by specialty (39.8%) and training level (57.6%). Of the included participants, 110 (47.6%) had ever inserted an IO needle, 105 (45.9%) received hands-on IO training, and 127 (55%) candidates received didactic IO teaching. Participation in adult resuscitation varied, with 37.2% involved in 1–10 cases and 7.8% in more than 100. While 75.8% emphasized the importance of rapid vascular access, only 41.1% were confident in using IO. Overall, 74% demonstrated good awareness and perception of IO use. Awareness was significantly higher among those with didactic teaching 80.3% vs. 66.3%, $p = .016$), hands-on training (79% vs. 71%, $p = .048$), and experience in 51–100 real-life resuscitations (90% vs. 73.6%, $p = .046$). **Conclusion:** Despite its critical importance, IO access remains underutilized in adult resuscitation in Saudi Arabia. The findings highlight the need for improved education and hands-on training, especially given the challenges of establishing vascular access in patients with burns, edema, obesity, or a history of IV drug use

Key Words Intraosseous access, resuscitation, vascular access, emergency medicine, Saudi Arabia

INTRODUCTION

Establishing vascular access is a cornerstone in the management of critically ill patients. While peripheral intravenous (IV) cannulation is commonly achieved with ease, failure or delay in obtaining access often necessitates alternative methods. Traditionally, central venous catheterization is the next step [1]. In fact, central venous access is the secondary option in 62% of unstable patients when peripheral IV routes are not feasible, and it remains the preferred choice even after the third attempt. Intraosseous (IO) access is typically considered only after the failure of multiple IV attempts [2,3]. IO access involves the insertion of a specialized needle into the bone marrow, allowing for rapid administration of fluids and medications or collection of blood samples [4]. It is safe, effective, and cost-efficient, proving particularly valuable when peripheral or central venous access is difficult, especially in emergency settings such as ambulances and intensive care units [4,5].

Globally, IO access has demonstrated efficacy across all age groups and is considered a reliable alternative in time-critical scenarios or in patients with difficult vascular access [5,6]. It plays a vital role in managing life-threatening

conditions such as cardiopulmonary arrest (CPA), shock, sepsis, trauma, severe burns, and status epilepticus [6]. Its speed and simplicity have even replaced the surgical cut-down of the great saphenous vein in emergencies [7,8]. Both cadaveric and clinical studies support IO access for its durability and ease of use [9-11]. With proper training, physicians, nurses, and paramedics are authorized to place, maintain, and remove IO access [12,13]. However, theoretical knowledge alone is insufficient; clinical experience and hands-on training are essential for competency [14]. Educational interventions have proven effective in enhancing healthcare providers' confidence and skills in using IO techniques [1,15]. Capability in this context refers to the integration of skill, knowledge, and self-efficacy needed to apply IO access appropriately [16].

Despite international recognition of IO access as a critical emergency tool, its use remains limited in some regions. In the Kingdom of Saudi Arabia (KSA), data regarding the actual utilization, perceived barriers, and level of knowledge related to IO access among physicians are scarce. It is crucial to determine such outcomes to provide a realistic forecast of the current use of IO access in the KSA. This will help healthcare providers to deliver high-quality educational programs for trainees while preserving the best healthcare practice for patients. There is no exact data regarding such implications, making the literature inconclusive to draw firm evidence for current practice.

Objectives and study hypothesis

This cross-sectional study was therefore conducted to evaluate the prevalence of IO access use, identify barriers limiting its use, and assess physicians' understanding and competence regarding IO access across different healthcare levels in Saudi Arabia. The primary objective of this study is to assess the prevalence of IO access utilization among physicians of varying levels in the Kingdom of Saudi Arabia (KSA). The secondary objectives are to identify the perceived barriers and limitations that prevent the use of IO access in clinical settings and to evaluate physicians' knowledge, training, and confidence regarding the procedure. It is hypothesized that IO access remains underutilized in KSA due to limited hands-on training, low confidence levels, and inadequate clinical exposure, particularly among physicians outside of emergency and critical care settings.

Hypothesis/Expected Outcome

The Authors hypothesize that IO access remains underutilized in KSA due to limited training, lack of confidence, and insufficient clinical exposure, particularly among non-emergency physicians.

METHODS

Study Design and Objectives

This study was a cross-sectional design to assess the use of IO access among healthcare providers in Saudi Arabia. The present study was performed based on strengthening the reporting of observational studies in epidemiology (STROBE) Statement guidelines for conducting cross-sectional studies [17]. This was an online cross-sectional study which was executed from March 2023 to March 2024.

Study Population

The study targeted all physicians in the Kingdom of Saudi Arabia. The study included physicians at different training levels (Interns, Residents, Fellows, Consultants), Emergency Medicine physicians, Intensive Care Unit (ICU) physicians, General Surgery physicians, Internal Medicine physicians, Anesthesia physicians, and adult physicians. Pediatric physicians were excluded.

Sample Size

The planned sample size of this study was approximately 300 healthcare professionals. The sample size was calculated to ensure a minimum of 50% participation of the medical professionals in the study. This was done to make the sample representative of the population and to facilitate adequate assessment of the study outcome measures. A convenience sampling strategy was used to recruit physicians working in various healthcare settings across Saudi Arabia. Although the estimated sample size was 300, based on an assumed prevalence of IO access use and allowing for a 5% margin of error at a 95% confidence level, only 231 responses were received and included in the final analysis, yielding a response rate of 83.7%. The lower response rate was attributed to time constraints and limited accessibility during the data collection period. Participants were enrolled using the convenience sampling method.

Data Collection Methods

Data were collected using an online survey that was distributed to eligible physicians through Email. Contact of all physicians and their data were obtained from the program directors. It was sent to physicians at public and private hospitals. We used an electronic survey to collect data on sociodemographic and a validated scale from the Ottawa Hospital Research Institute after obtaining permission from the copyright owner to use it. All participants who were included in the survey agreed to fill out the questionnaire before filling it. The data protection officer at King Saud University approved the study. It was conducted according to the principles set by the medical ethics board of King Saud University Medical City.

Tool Validation

A pilot test was also conducted among 15 physicians to assess clarity, reliability, and internal consistency, with necessary modifications made before distribution. Participation was voluntary, and informed consent was obtained electronically. The survey was distributed through professional networks, hospital contacts, and online platforms. A structured web-based online survey was prepared using google form to collect the data. Most of the questions were multiple-choice, whereas few were open-

ended. The questionnaire was pre-tested on a small sample of participants to confirm the practicality and clarity of questions using the pilot test. The reliability of the questionnaire was assessed using the Cronbach alpha coefficient test. The content validity was evaluated using the Cohen's kappa test.

Data Analysis

The data were collected, reviewed, and then analyzed using Statistical Package for Social Sciences version 21 (SPSS: An IBM Company). All statistical tests were two-tailed with an alpha level of 0.05, considering the result significant if the P value was less than or equal to 0.05. The overall awareness of IO procedures was evaluated by summing the scores from various awareness items. The knowledge score was categorized as "poor" if the participant's score was below 60% of the total possible score, and as "good" if the score was 60% or higher based on Bloom's cutoff points used in many studies. Descriptive analysis included frequency distribution and percentage calculations for study variables such as participants' personal information, specialty, and training level. Additionally, participants' attitudes, prevalence, and teaching of intraosseous access in adult resuscitation, as well as their awareness and perception, were presented in tables, with the overall awareness level displayed in a graph. Cross-tabulation was used to examine factors associated with participants' awareness of intraosseous access, with statistical significance tested using Pearson's chi-square test, or the exact probability test when frequencies were small. Logistic regression was not conducted to assess the factors influencing the awareness level of intraosseous (IO) access due to the distribution of responses. The majority of participants reported high awareness levels, resulting in limited variability within the data. This lack of sufficient variance made it difficult to perform a meaningful regression analysis, as logistic regression requires a substantial proportion of participants across both the outcome categories (e.g., high vs. low awareness) to ensure reliable results. As a result, descriptive statistics and basic bivariate analyses were used to capture and present the data effectively.

RESULTS

A total of 231 healthcare providers completed the study questionnaire. Participants' ages ranged from 21 to 70 years, with a mean age of 26.1±12.8 years. There were 123 (53.2%) males and 108 (46.8%) females. As for medical specialty, 92 (39.8%) were interns, 57 (24.7%) were in emergency medicine specialty, 21 (9.1%) were in internal medicine, 20 (8.7%) were in general surgery, and 20 (8.7%) were in other specialties while anesthesia was reported by 8 (3.5%), ICU by 8 (3.5%), and family medicine by 5 (2.2%). A total of 133 (57.6%) were interns, 38 (16.5%) were consultants, 41 (17.7%) were residents, and 14 (6.1%) were fellows. A total of 173 (47.9%) were staff physicians for 1-4 years, 24 (10.4%) for 5-9 years, 23 (10%) for 10-19 years, and only 11 (4.8%) for 20 years or more (Table 1).

Table 1: Demographic characteristics of study health care providers, Saudi Arabia

Demographic Data	No	Percentage
Age in Years		
21-29	150	64.9%
30-39	47	20.3%
40-49	16	6.9%
50-59	11	4.8%
60-70	7	3.0%
Gender		
Male	123	53.2%
Female	108	46.8%
What Medical Specialty Is Your Training In?		
Intern	92	39.8%
Emergency Medicine	57	24.7%
Internal Medicine	21	9.1%
General Surgery	20	8.7%
Others	20	8.7%
Anesthesia	8	3.5%
Intensive Critical Care (ICU)	8	3.5%
Family Medicine	5	2.2%
What Level of Training Are You in as a Physician?		
Consultant	38	16.5%
Intern	133	57.6%
Resident	41	17.7%
Fellow	14	6.1%
Specialist	4	1.7%
Paramedic Specialist	1	0.4%
How Many Years Have You Been a Staff Physician?		
1-4	173	74.9%
5-9	24	10.4%
10-19	23	10.0%
20+	11	4.8%

A total of 109 (47.6%) of the study participants inserted an IO needle (either in a model or in real life). This was 1-5 times among 28.8% of participants, 6-10 times among 8.7% of participants, and more than 10 times among 10%. A total of 127 (55%) participants had didactic teaching about IO, and 105 (45.9%) had hands-on training with IO. Of the included participants, 86 (37.2%) directly involved in real-life adult resuscitations for 1-10 times, 35 (15.2%) directly involved for 11-50 times, 20 (8.7%) directly involved for 51-100 times, and 18 (7.8%) for more than 100 times (Table 2).

A total of 75.8% agreed that achieving rapid vascular access is important for fluid resuscitation. Of them, 71.4% believed that using an IO for fluid resuscitation could be beneficial when peripheral IV access is not possible, and 70.1% felt it is crucial to rapidly infuse fluids during a resuscitation. Additionally, 69.7% agreed that IO access would be useful when IV access cannot be achieved. Only 29% believed there is a negative stigma associated with using an IO (e.g., reluctance to perform a central line or lack of skill with IVs), and 15.6% expressed hesitation to use an IO due to concerns about how others might perceive them.

Regarding the indications for IO use, 47.2% believed it was expected of them to use an IO for fluid resuscitation when peripheral IV access is not possible, 42% felt that hospital culture expects them to use an IO in such cases, and 41.1% reported that their colleagues, who are important to them, think they should use an IO when IV access is not

Table 2: Prevalence and teaching of intraosseous access in adult resuscitation among healthcare providers in Saudi Arabia

Frequency	No	%
How many times have you inserted an IO needle (either in a model or in real life)?		
Never	120	52.4%
1-5	66	28.8%
6-10	20	8.7%
> 10	23	10.0%
Have you had any didactic teaching about IO?		
Yes	127	55.0%
No	104	45.0%
Have you had any hands-on training with IO?		
Yes	105	45.9%
No	124	54.1%
Approximately how many real-life adult resuscitations have you been directly involved in?		
None	72	31.2%
1-10	86	37.2%
11-50	35	15.2%
51-100	20	8.7%
> 100	18	7.8%

Table 3: General attitude and competency of using intraosseous access among physicians, Saudi Arabia

Attitude and Perception Items	Disagree	Neutral	Agree
If I were faced with a situation where I was caring for an adult patient who needed immediate fluid resuscitation, and peripheral IV access was not achievable, I would want to use an IO.	15.6%	24.7%	59.7%
It would be clinically useful to use an IO for fluid resuscitation when a peripheral IV is not achievable.	16.5%	19.0%	64.5%
I am hesitant to use an IO.	32.1%	28.1%	39.8%
In a situation where IV access is not achievable, I think using an IO for fluid resuscitation would be useful.	11.3%	19.0%	69.7%
When peripheral IV access is not possible, using an IO for fluid resuscitation could be beneficial to the patient.	9.5%	19.0%	71.4%
IO can provide rapid vascular access.	11.7%	22.9%	65.4%
For fluid resuscitation, achieving rapid vascular access is important.	8.2%	16.0%	75.8%
IO should be utilized more often in adult resuscitations when IV access is not achievable.	13.9%	32.0%	54.1%
I would feel more comfortable using an IO if it were more frequently utilized in adult resuscitations.	14.7%	32.9%	52.4%
It is important to be able to rapidly infuse fluids during a resuscitation.	11.7%	18.2%	69.7%
Inserting an IO could be painful for the patient.	9.5%	26.4%	64.1%
Causing a patient pain with an IO would be upsetting to me.	20.8%	30.7%	48.5%
I am more likely to perform a procedure if it is associated with low complication rates.	11.7%	23.4%	64.9%
If IO only provides temporary access, I am less likely to use it.	34.2%	35.1%	30.7%
I am concerned that people may prematurely resort to inserting an IO without first attempting a peripheral IV.	24.7%	34.2%	41.1%
There is a negative stigma attached to using an IO (e.g., unwilling to do a central line, unskilled at doing IVs).	26.5%	44.6%	29.0%
I would be hesitant to use an IO because of what people might think of me.	50.7%	33.8%	15.6%
Trying at a peripheral IV before considering insertion of an IO is important to me.	8.3%	22.5%	69.3%

Table 4: Attitude and competency of using intraosseous access among physicians, Saudi Arabia, continued

Domain	Attitude Item	Disagree	Neutral	Agree
Social Influence	Colleagues think I should use an IO for fluid resuscitation when IV access is not achievable	21.7%	44.2%	41.1%
	It is expected of me to use an IO when IV is not achievable	15.2%	37.7%	47.2%
	I feel hospital culture expects me to use an IO when IV is not achievable	20.8%	37.2%	41.9%
Support & Comfort	Nurses would be supportive of me using an IO	16.0%	43.3%	40.7%
	It is important to have the support of nurses when using an IO	11.3%	33.3%	54.9%
Knowledge & Familiarity	Most healthcare professionals are unfamiliar with the utility of IO	19.9%	41.6%	34.6%
	It would be difficult to use an IO because my colleagues are not familiar with it	25.1%	39.0%	35.9%
	Healthcare professionals are not comfortable with IO because it is rarely used	19.5%	39.8%	40.7%
Practical Use	If IO's were more frequently used, others would be more comfortable with me inserting one	13.4%	32.9%	53.7%
	The IO equipment is not readily accessible	20.8%	45.0%	34.2%
	Having IO equipment close by would make it easier for me to use an IO	9.5%	31.2%	59.4%
Training & Protocols	Printed protocols can be helpful when performing a new procedure	13.9%	24.2%	62.0%
	If I had a printed protocol, it would make it easier to use an IO	14.8%	27.3%	57.9%
Post-Insertion Care	Most nurses lack training in IO post-insertion care	14.7%	52.8%	32.5%
	I would be more likely to insert an IO if nurses were adequately trained in post-care	14.8%	32.5%	53.2%
Leadership & Experience	Residents are more likely to perform a procedure if their attending has prior training	9.1%	25.5%	65.4%
	Providing IO training to attendings will increase IO use among residents	9.1%	24.7%	66.3%
Comfort with Equipment	Prior handling of an IO drill would increase my comfort with its use	11.2%	23.8%	65.0%
	For me to insert an IO, I need to be comfortable with using the IO drill	9.6%	23.4%	69.0%
Knowledge of Indications	It is important to educate physicians about IO indications and contraindications	8.7%	21.6%	69.7%
	To use an IO, I need to know when it is appropriate and when it is not	7.8%	24.2%	70.4%
Perceived Ease of Use	I think an IO is simple to insert	36.8%	35.1%	28.1%
	If inserting an IO is difficult, I will not use it	36.8%	35.1%	28.1%
	I think using an IO would be easy	26.4%	36.4%	37.2%
Autonomy	Whether I use an IO or not is entirely up to me	35.1%	35.1%	29.9%
	I am confident I could use an IO if I wanted to	26.5%	32.5%	41.1%

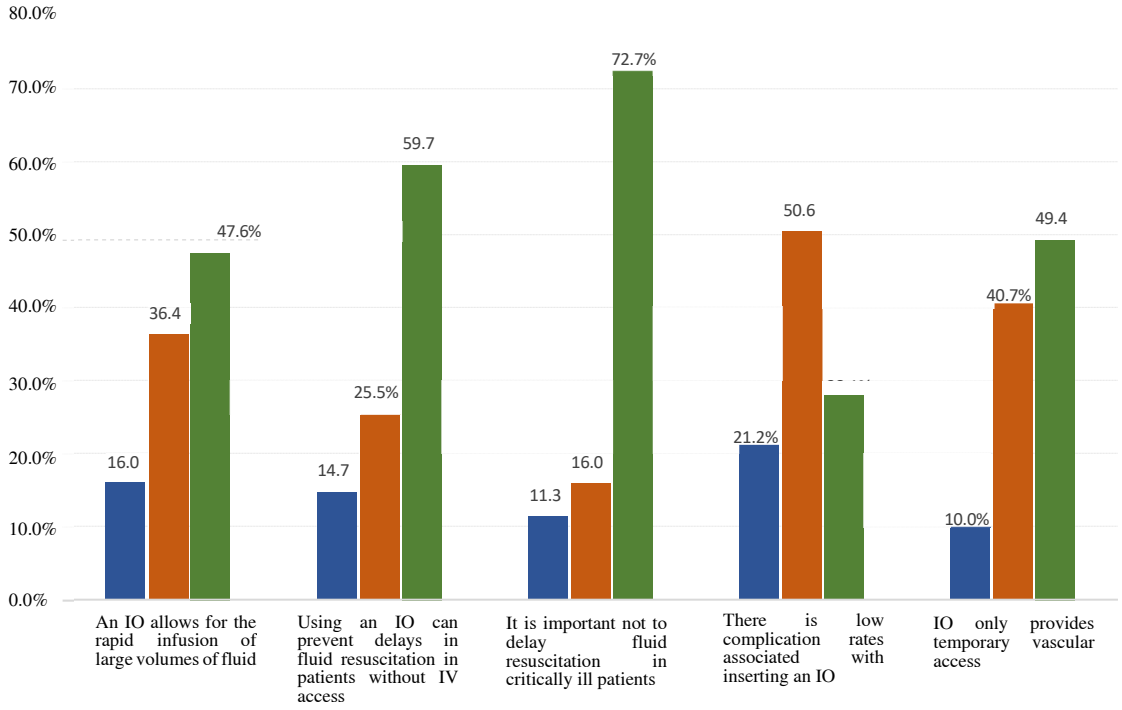

Figure 1: Awareness and perception of intraosseous access use among physicians, Saudi Arabia

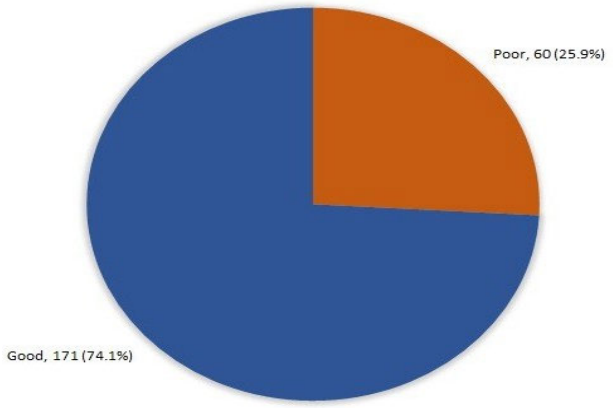

Figure 2: Overall awareness about intraosseous access use among physicians, Saudi Arabia

achievable. In terms of support, 55.4% stated that having the support of nurses is important when using an IO, 53.7% agreed that greater use of IOs in the hospital would make others more comfortable with them inserting an IO needle, and 40.7% felt that nurses would be supportive of using an IO. However, 40.7% also reported that healthcare professionals (MDs, RNs, RTs) are not comfortable with IOs because they are rarely used. Regarding tool availability, 61.9% thought printed protocols would be helpful as a guide when performing a new procedure, 59.3% believed having IO equipment readily available during a resuscitation would make it easier to use, and 58% thought that having a printed protocol would facilitate the use of an IO. In terms of training and education, 69.7% considered it important to educate physicians on the indications and contraindications of IO insertion, 68% thought they needed to know when it is appropriate or not to insert an IO, 67.1% felt they needed to be comfortable using the IO drill, and 66.2% agreed that providing IO training to attending physicians would increase IO use among residents. When it came to the ease of using IOs, 41.1% were confident they could use an IO if needed, 37.2% thought using an IO would be easy, and 29.9% believed whether they used an IO was entirely their decision. However, only 28.1% considered IO insertion to be simple and stated that if inserting an IO were difficult, they would not use it (Table 4).

A total of 72.7% knew that it is important not to delay fluid resuscitation in critically ill patients, and 59.7% stated that using an IO can prevent delays in fluid resuscitation for patients without IV access. Additionally, 49.4% believed that IO provides only temporary vascular access, while 47.6% reported that IO allows for the rapid infusion of large volumes of fluid. Only 28.1% thought that the complication rates associated with inserting an IO were low. As for the overall awareness about intraosseous access use among physicians, a total of 171 (74%.1 %) of the study's healthcare practitioners had an overall good awareness and perception of IO (Figure 1 and 2).

Didactic teaching was significantly associated with higher awareness levels ($p = 0.016$). Specifically, 80.3% of those who had received formal teaching showed good awareness compared to only 66.3% of those without such training. This suggests that structured educational sessions may play a crucial role in improving knowledge about IO access. Similarly, the number of real-life resuscitation experiences was significantly related to awareness ($p = 0.046$). Physicians who had participated in more than 50

Table 5: Factors associated with awareness level about intraosseous access use among physicians, Saudi Arabia

Factors	Poor awareness		Good awareness		p-value
	No	%	No	%	
Age in years					
21-29	39	26.00%	111	74.00%	0.965[$]
30-39	13	27.70%	34	72.30%	
40-49	4	25.00%	12	75.00%	
50-59	3	27.30%	8	72.70%	
60-70	1	14.30%	6	85.70%	
Gender					
Male	32	26.00%	91	74.00%	0.988
Female	28	25.90%	80	74.10%	
What medical specialty is you training in?					
Anesthesia	1	12.50%	7	87.50%	0.906
Emergency Medicine	16	28.10%	41	71.90%	
Family Medicine	2	40.00%	3	60.00%	
General Surgery	6	30.00%	14	70.00%	
Intensive Critical Care (ICU)	1	12.50%	7	87.50%	
Intern	22	23.90%	70	76.10%	
Internal Medicine	6	28.60%	15	71.40%	
Others	6	30.00%	14	70.00%	
What level of training are you in as a physician?					
Consultant	4	10.50%	34	89.50%	0.132
Intern	39	29.30%	94	70.70%	
Others	6	40.00%	9	60.00%	
Resident	10	24.40%	31	75.60%	
Specialist	1	25.00%	3	75.00%	
How many years have you been a staff physician?					
4-Jan	48	27.70%	125	72.30%	0.677
9-May	6	25.00%	18	75.00%	
19-Oct	4	17.40%	19	82.60%	
20+	2	18.20%	9	81.80%	
How many times have you inserted an IO needle (either in a model or in real life)?					
Never	29	24.20%	91	75.80%	0.344
5-Jan	19	28.80%	47	71.20%	
10-Jun	7	35.00%	13	65.00%	
> 10	3	13.00%	20	87.00%	
Have you had any didactic teaching about IO?					
Yes	25	19.70%	102	80.30%	0.016*
No	35	33.70%	69	66.30%	
Have you had any hands-on training with IO?					
Yes	22	21.00%	83	79.00%	0.048*
No	36	29.00%	88	71.00%	
Approximately how many real-life adult resuscitations have you been directly involved in?					
None	19	26.40%	53	73.60%	0.046*
10-Jan	28	32.60%	58	67.40%	
Nov-50	9	25.70%	26	74.30%	
51-100	2	10.00%	18	90.00%	
> 100	2	11.10%	16	88.90%	

adult resuscitations demonstrated notably higher awareness (≥88.9%) compared to those with fewer or no experience. This trend indicates that practical exposure to emergencies may reinforce the importance and application of IO access techniques. On the other hand, gender, age, medical specialty, level of training, and years of experience as a staff physician showed no statistically significant associations with awareness levels ($p > 0.05$). Interestingly, even though consultants exhibited the highest proportion of good awareness (89.5%), this difference was not statistically significant, likely due to the smaller sample size in this subgroup. Additionally, hands-on training showed a positive, although not statistically significant, association with better awareness (79.0% vs. 71.0%; $p = 0.344$), suggesting a potential benefit that might become clearer with larger sample sizes or more detailed skill assessments. Lastly, the number of times a physician had previously inserted an IO needle did not reach statistical significance ($p = 0.677$), but physicians who had performed more than 10 insertions showed the highest awareness level (87%), hinting at a possible dose-response relationship between experience and knowledge (Table 5).

DISCUSSION

The current study revealed that the vast majority of our participants have been participating in inserting an IO access at least once in a model or in real life. Also, most of them agreed to use IO access when there is difficulty in finding IV

access and when they need rapid resuscitation for the patient. A systematic review was done in 2023 about the use of IO in traumatic patients and found that IO access is more successful for trauma patients than IV access and takes less time to complete surgery. It is recommended for expedient vascular access in hypotensive trauma patients, especially those in shock, as shock causes vasoconstriction and blocked microcirculation, making it challenging for medical professionals [18]. However, few of them report that they are going to be hesitant to use it because of what people might think of them. Moreover, some participants might not intend to perform the procedure when they felt there was a stigma associated with IO access. The study also showed how physicians' behavior toward the use of IO access changed regarding social pressure from healthcare professionals. According to the survey, physicians were less likely to state their intention to employ this kind of access in adult resuscitation if they believed that nurses were unfamiliar with or opposed to IO insertion. The critical role played by nurses in establishing and maintaining venous access, as well as their capacity to influence the appropriate use of IO infusions in emergency department settings, is acknowledged by Voigt *et al.* [19] in their systematic review. Some of the participants reported that they do not prefer to use IO access because it is rarely used in the hospital, and they would be more comfortable with the procedure if it were more frequently used. However, a systematic review done by Petitpas *et al.* [4] showed that IO access is an emergency procedure that can be learned easily. Success rates vary depending on the training, with manual needles having a lower success rate than semiautomatic devices. After training, the success rate of EZ-IO® devices increases to 97% after two attempts. However, manual devices can still achieve a high success rate. Our survey showed that many physicians may intend to use IO access if they were more trained. A study done by Warren James Cheung [1] suggests that educational interventions targeting physicians' attitudes, norms, and control beliefs can enhance their use of IO access in adult resuscitation. Factors such as ease of access, vascular safety, and low complication rate influence usage. Social pressures and lack of trust in indications and contraindications also influence usage.

The low utilization rate observed in this study is consistent with findings from other regions. A study in the United Arab Emirates (UAE) reported that only 42% of emergency physicians had used IO access in resuscitation, citing lack of familiarity and training as major barriers [20]. Similarly, a survey of emergency departments in the United States found that while IO access was recognized as a critical tool, only 55% of providers used it regularly in adult resuscitation [21]. In contrast, countries with well-established IO training programs, such as the UK and Australia, report higher utilization rates (>70%), emphasizing the role of structured education and clinical exposure in improving adoption [22 23].

Regarding awareness of IO access, most of the participants had high awareness regarding the use of access. This study found that didactic teaching and hands-on training significantly improved awareness. These results are supported by a meta-analysis by Reades *et al.* (2021), which demonstrated that simulation-based IO training increased successful insertion rates by 35% [24]. Similarly, a study in Canada showed that mandatory IO training for emergency residents improved utilization rates from 40% to 75% within two years [25]. Moreover, institutional and system-level factors may also influence the awareness and use of IO access [26]. These include the availability of IO devices in emergency departments, the presence of standardized training programs, and hospital policies supporting IO use in critical situations [24]. A lack of institutional focus on IO access may contribute to limited hands-on experience and hesitancy among physicians, despite individual knowledge or willingness. Future studies should examine these broader determinants to better understand and address barriers at the organizational level.

Study strengths and limitations

The current study offers nationwide coverage by including physicians from diverse regions and across various levels of training and specialties, enhancing the generalizability of the findings. By examining both didactic education and hands-on training, the study provides a comprehensive understanding of the factors influencing awareness and use of intraosseous (IO) access. Moreover, it addresses a critical but often overlooked aspect of emergency medicine, shedding light on the clinical significance of IO access in resuscitation scenarios and identifying opportunities for targeted improvement in medical education and practice. On the other hand, several limitations should be noted. First, data were collected through a self-administered questionnaire, which may be subject to recall bias or social desirability bias, potentially affecting the accuracy of the responses. Second, the study included physicians from various specialties and training levels; the sample may not be fully representative of all physicians across Saudi Arabia, limiting the generalizability of the findings. Finally, the study did not explore institutional factors or the availability of IO devices, which could also impact awareness and usage but were beyond the scope of this research. Also, the lack of inferential statistics or regression limits the depth of conclusions

Generally, due to its broad geographic and professional scope, the study makes an important contribution by providing new local data on the use of intraosseous (IO) access among physicians in Saudi Arabia a topic with limited prior exploration in the region. It effectively addresses a practical and pressing gap in emergency medicine training and adoption by highlighting current practices, levels of awareness, and barriers to IO utilization. While the descriptive nature of the analysis may limit its capacity to infer causal relationships or predictive factors, the study still offers valuable insights that can inform future educational strategies, policy development, and more advanced analytical research.

CONCLUSIONS AND RECOMMENDATIONS

In conclusion, our study revealed a generally high level of awareness and positive attitudes among physicians in Saudi Arabia regarding intraosseous (IO) access, chiefly among those with prior didactic or hands-on training. However, gaps remain in practical experience, confidence, and institutional support. Social influences, limited exposure, and infrequent clinical use continue to affect physicians' willingness to employ IO access in emergencies. Based on that, authors recommend the integration of structured IO access training, including both didactic and simulation-based components, into undergraduate medical curricula and continuous professional development programs. Hospitals should ensure the availability of IO devices and foster a supportive environment by establishing clear clinical guidelines and protocols for IO use. National-level policies and institutional legislations are also needed to standardize IO access practices across healthcare settings and promote their appropriate use in emergency care for healthcare staff and nurses. Finally, interventional or longitudinal studies are recommended in the future for a more in-depth understanding of the procedure context.

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Ethical consideration

This study was conducted following ethical guidelines by the Declaration of Helsinki. Approval was obtained from the relevant ethics review board, and informed consent was secured from all participants, ensuring their voluntary involvement, confidentiality, and the right to withdraw at any time. Data were anonymized and stored securely, with access restricted to authorized personnel. The study adhered to ethical principles, prioritizing participant well-being and minimizing potential risks.

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